REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1 to 8 in the underlying PCT Application No. PCT/DE2004/001733 and adds new claims 9 to 17. The new claims, inter alia, conform the claims to United States Patent and Trademark Office rules and does not add any new matter to the application.

In accordance with 37 C.F.R. § 1.125(b), the Substitute Specification (including the Abstract) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to United States Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(ii) and 1.125(c), a Marked-Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/DE2004/001733 includes an International Search Report, dated November 24, 2004, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

It is respectfully submitted that the subject matter of the present application is new, non-obvious and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

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CONTACT SURFACES FOR ELECTRICAL CONTACTS

FIELD OF THE INVENTION

The present invention relates to improved contact surfaces for electrical contacts ~~according to the definition of the species in the independent claim~~.

~~Related Art~~

BACKGROUND INFORMATION

Electrical connectors such as bushings and plugs are typically produced from a substrate made of an alloy on copper basis, which provides good electrical conductivity. If the electrical connector is exposed to higher temperatures during operation, such as under the engine hood of a motor vehicle, the substrate is made from an alloy on copper basis having high stability and a high strain-relaxation resistance.

A cover layer is often applied on the substrate to reduce tarnishing of the copper-based substrate at higher temperatures and to improve the soldering ability. Typical cover layers are made of nickel, palladium/nickel alloys, tin or tin alloys. To minimize costs, tin is often used, predominantly fire-tinned or galvanically deposited layers in the range of a few μm. Tin is characterized by its ductility and its excellent electrical conductivity.

The substrate is usually made of copper-based alloys such as $CuSn_4$-bronze, CuNiSi, etc., which often serve as base material for electrical plug-in connections. At higher temperatures it may happen that copper diffuses out of the substrate and combines with the tin, forming intermetallic compounds such as Cu_6Sn_5 and Cu_3Sn. The formation of such intermetallic compounds reduces the quantity of unreacted or free tin on the surface.

This has a detrimental effect on the electrical, corrosion and other performance characteristics.

A "tin layer" produced by heat treatment is ~~known~~ **referred to** as thermo-tin, which is made of intermetallic phases to 100%. Also frequently used are AuCo alloys having nickel undercoating, and Ag surfaces, partly having copper undercoating or nickel undercoating.

So far, however, thermo tin has not shown to be a successful solution in all test situations (such as chemical testing or abrasive loading), and therefore has no more than a very small marketing share.

Moreover, it is ~~known~~ **conventional** that tin alloys, due to their low hardness or their low wear resistance, have a tendency to increased oxidation (chafing corrosion) and to abrasion as a result of frequent plug-ins or vehicle-related or engine-related vibrations in the plug connector. This abrasion or chafing corrosion may lead to malfunctioning of a component (sensor, control unit, electrical components in general).

In addition, due to the high adhesion tendency and the plastic deformation, the plug forces are too high for many application situations such as plug connectors having a high number of ~~poles)~~ **(poles, e.g.,** > 100 pins or contacts). Surfaces on the basis of tin and silver, in particular, have a cold welding tendency because of adhesion, and in self pairings are characterized by high friction values (coefficients of friction).

Even with conventional silver or gold layers, tribological wear mechanisms of the base material or the intermediate layer

(frequently Cu or Ni) may occur with layer abrasion or layer chipping, due to poor adhesion.

EU directive "Altautorichtlinie" 2000/53 forbids the use of lead-containing tin layers. Since the lead inhibits whisker formation (whiskers are tiny, hair-like crystals), galvanic pure tin promotes whisker growth, which may lead to short-circuits.

In ~~U.S. A 5,028,492~~ **U.S. Patent No. 5,028,492**, a composite coating for electrical contacts is described, which includes a ductile metal matrix and a uniformly distributed polymer component. The polymer component is present in a concentration that reduces the frictional forces that occur when a contact is inserted into a corresponding receptacle. The composite coating provides lower friction and improved frictional oxidation compared to a galvanically deposited tin coating.

~~U.S. A 5,916,695 discloses~~ **U.S. Patent No. 5,916,695 describes** an electrical contact having a copper-based substrate, which has been provided with a tin-based cover layer. To prevent diffusion of the copper from the substrate into the cover layer and the attendant formation of intermetallic layers, a barrier layer is applied between the substrate and the cover layer. This barrier layer contains 20 to 40 weight % of tin and preferably is mostly made up of copper (Cu base). Among others, the tin-based cover layer may include additives such as SiO_2, Al_2O_3, SiC, graphite or MoS_2 as lubricants.

~~Advantages of the Invention~~

SUMMARY

In contrast to the ~~related art~~ **foregoing**, the contact surfaces according to **example embodiments of** the present invention ~~have the advantage~~ **may provide** that they require low plug-in forces while still supplying excellent electrical contacting.

Moreover, it ~~is advantageous~~ **may be provided** that they protect the surface from corrosion due to the antioxidants contained in the lubricant.

Furthermore, ~~there is the advantage of~~ increased wear protection and thus of an increased service life of the contacts **may be provided**.

~~Advantageous further developments of the present invention result from the measures indicated in the dependent claims.~~

~~Brief Description of the Drawing~~

~~An exemplary embodiment~~ **Example embodiments** of the present invention ~~is represented in the drawing and elucidated~~ **are described** in greater detail ~~in the following description~~ **below with reference to the appended Figure**.

BRIEF DESCRIPTION OF THE DRAWING

The ~~figure shows~~ **Figure illustrates** the arrangement of the graphite particles in an Ag contact layer.

~~Exemplary Embodiments~~

DETAILED DESCRIPTION

~~The core~~ **Example embodiments** of the present invention [[is]] **provide for** the construction of an Ag cover layer, which has finely dispersed graphite particles embedded therein, on a copper-based substrate for electrical contacts in the automobile, which ~~requires~~ **may require** lower plug-in forces while providing the same satisfactory contacting.

As illustrated in the ~~figure~~ **FIgure**, an Ag contact surface 12 is first produced on the electrical contact, i.e., on copper-

based substrate 10, using galvanic methods such as baths or reel-to-reel methods.

The Ag layer may be deposited with or also without intermediate layers as diffusion barriers, such as a tin undercoating, and also with or without flash of noble metals such as Au, Pt, Ru or Pd.

~~According to the present invention, the~~ **The** layer thickness of the deposited Ag layer [[is]] **may be** between approximately 1.0 and approximately 10 μm, depending on the application.

Finely dispersed graphite particles 14 ~~have been~~ **are** introduced into the Ag layer, for ~~instance~~ **example,** by intermingling of graphite and chemical auxiliary agents for binding (wetting agent), the graphite quantities ~~lying~~ **being** in the range of**, e.g.,** 1 to 3 weight % of carbon of the Ag layer, or in the range of**, e.g.,** 3 to 10 surface % of carbon. The graphite particles ~~are preferably~~ **may be** present as platelets or flakes and have a length of**, e.g.,** between 1 and 10 μm, a thickness**, e.g.,** in the range of 0.05 to 2 μm, and a width**, e.g.,** in the range of 0.05 to 2 μm. It ~~is preferred if~~ **may be provided that** the maximum value for thickness and width, i.e., 2 μm, does not occur simultaneously. ~~In a preferred specific embodiment, the~~ **The** graphite particles ~~are~~ **may be** disposed anisotropically along the habitus plane of the Ag layer, i.e., along the longest axis of the layer plane (cf. the ~~figure~~ **Figure**).

The aspect ratio of the graphite particles, i.e., the ratio of length to thickness, ~~preferably amounts to~~ **may be, e.g.,** 1:2 to 1:40.

The contact surfaces ~~according to the present invention~~ **may** allow lower plug-in forces as a result of the included

graphite lubricant. Good contacting [[is]] **may be** ensured by the electrical conductivity of the lubricant. Antioxidants ~~contained~~ **included** in the lubricant protect the surfaces from corrosion, thus providing high wear resistance and a high number of plug-in cycles.

The contact surfaces ~~according to the present invention are preferably~~ **may be** used in electrical contacts in automotive plug connections that are in close proximity to the engine.

~~Abstract~~

ABSTRACT

A contact surface for electrical contacts ~~is provided,~~ **may include** an Ag layer ~~having been~~ deposited on a copper-based substrate using galvanic methods. The Ag layer includes finely dispersed graphite particles in a quantity of**, e.g.,** 1 to 3 weight % of the Ag layer, the graphite particles having a length in the range of**, e.g.,** 0.5 to 20 μm.

~~Fig. 2~~